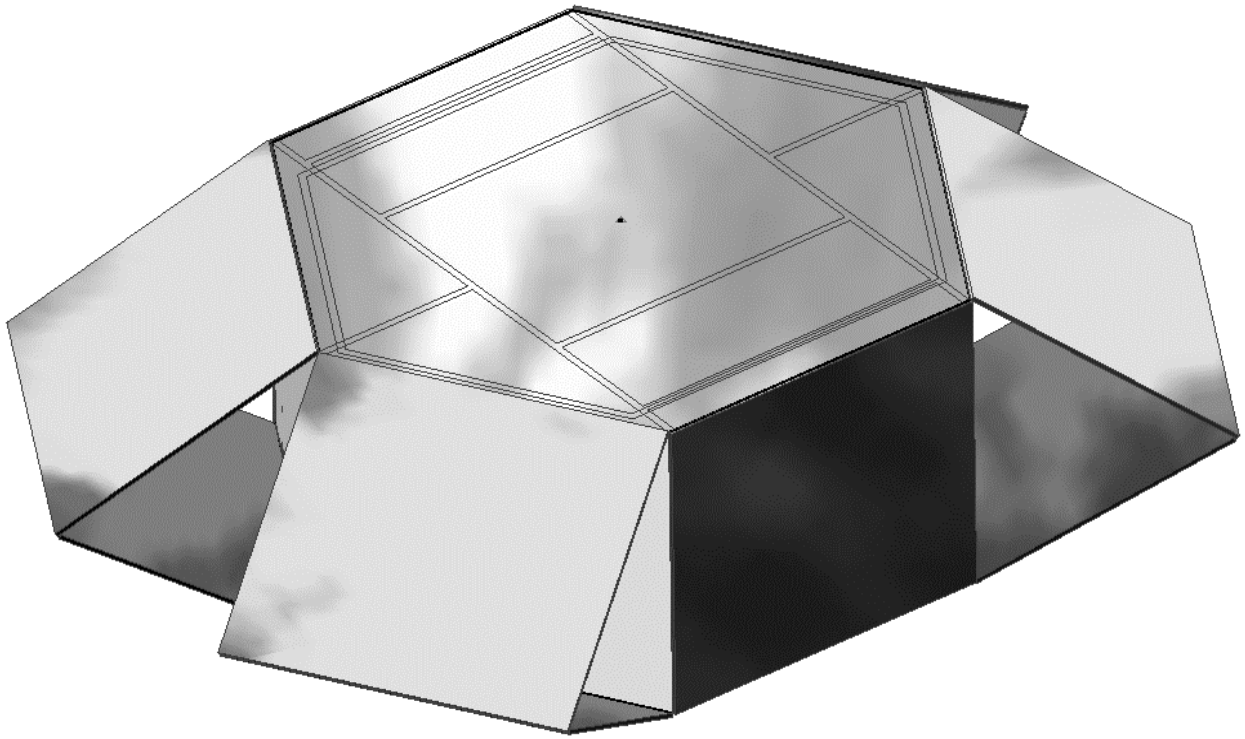
Eagle Mechanical Status

AMSAT Space Symposium
Pittsburgh, PA
October 27, 2007
Robert Davis, KF4KSS

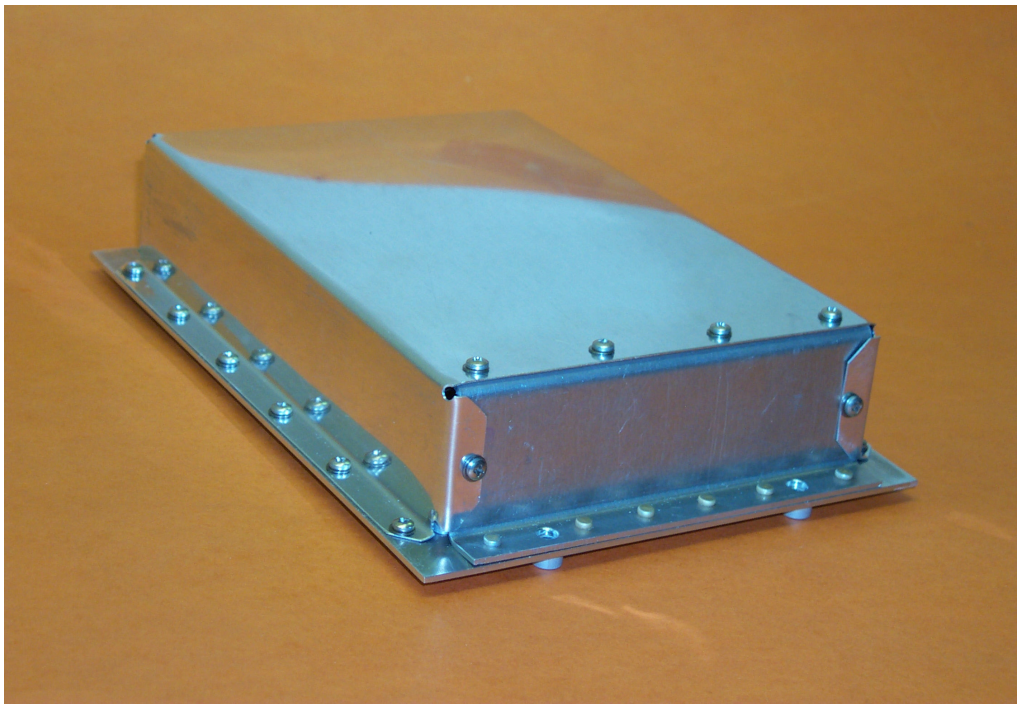
Eagle Shape

- 6 sides, reminiscent of AO-40
- But smaller! 2’ tall and 4’ diameter
- Deployable solar panels
- Little change in the last year
- Minimal effort to continue detailing



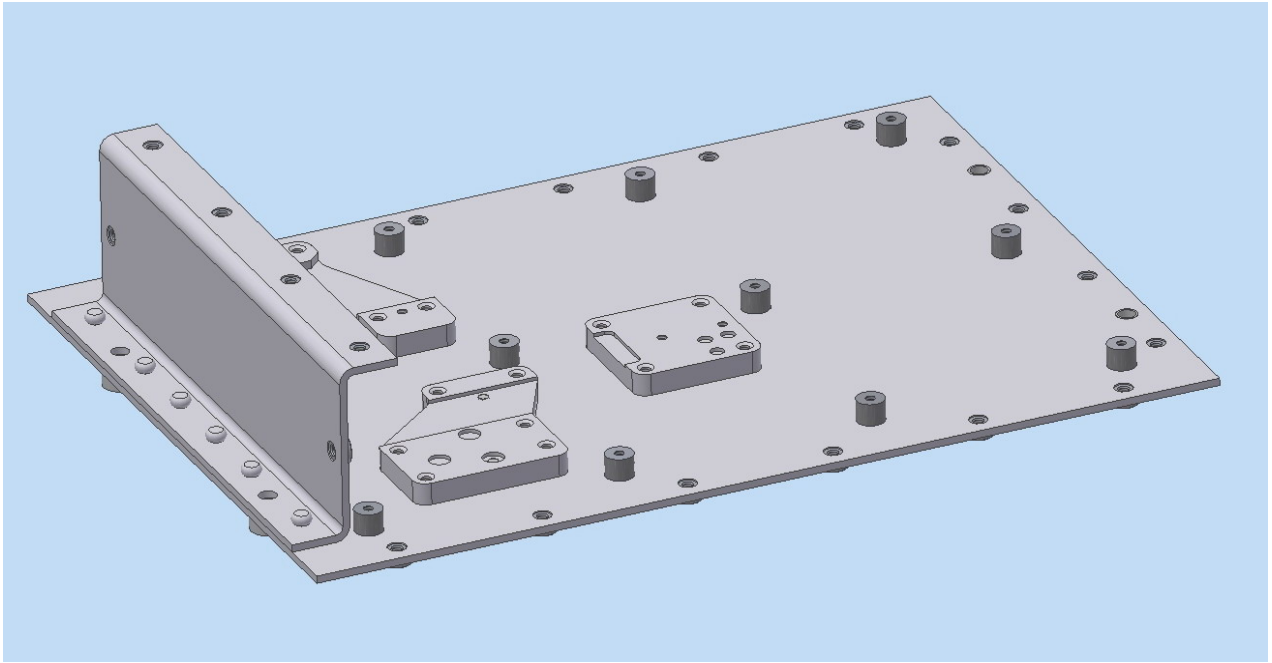
Prototype Electronics Modules

- A few fabricated to facilitate peer review
  - Wanted to hold it, not just read about it
- One of these given to U-band Rx
- Several lessons learned



Module Recap

- 3 sizes
  - 125x180, 200x180 and 275x180 mm
- Small is the “typical” size. Large is unlikely.
- PCB mounts to Baseplate, then Cover added.



Module Fabrication

- Want a module that can be “mass produced” yet have modularity
  - Any Cover will fit.
- Emphasis on process of fabrication for repeatability
  - Fixtures created for placement of bends & holes
  - Up until we added U-band Rx connector holes at last minute…
- Design is focused on sheetmetal and PCB access
- Significant effort by Fred Park KF0AK

Lessons Learned from Fabrication

- Many bends are harder to control
  - Cover looks good, but rocks on 2 corners
- Fixtures for fabrication are useful/required
- Pristine clad needs protection from scratching during bending, etc

Lessons Learned from U Rx

- Agree to modify a part only when the mill is working…
- Sheetmetal Baseplate is susceptible to bending
- PCB exposed to unnecessary bending
  - First when bolted to Baseplate
  - Second when that assembly sees stiffer Cover
- Angle of bend on Connector Bracket exposes solder on pins of 90° D-subs to extra stress

More Lessons from U Rx

- Height of COTS standoffs and custom heatsinks under PCB must match
  - Tolerance of COTS & custom was assumed but not measured
  - Difference tends to warp PCB
- Some standoffs were loose (could rotate)
  - Reviewing style of standoffs
- Placement of components inside module affects interference susceptibility
- More flexible to avoid attachment screws under connectors

Next Steps for Modules

- Requirements document has been drafted and is in peer review cycle
- Modifying design of module to incorporate lessons learned
- Baseplate is now machined for greater stiffness
- Still comparing
  - full-height milled with flat cover

    vs
  - short milled with bent cover
- Complete changes and peer review
- Complete documentation in addition to drawings
- Fabricate new prototype

Back to Eagle spaceframe

- Lab volunteers fabricated ½ scale Eagle for Dayton Hamvention and Space Day at the National Air & Space Museum
- Representative of shape, not structure
- Useful already in antenna, solar panel and module packaging discussions

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Solar Panel Sizing

- Shape & size imply power range
- Solar panels can be angled for less or more power
  - This is not a simple trade-off of more is better
- I made Excel spreadsheet to help visualize size, shape and power generated
  - Actually, I was having fun and it happens to be useful…
- Bob McGwier N4HY, Lou McFadin W5DID and I agreed on baseline at Dayton Hamvention

Satellite Shape		
6	# of sides	
580.00	Width of sides	
Ø1160.00	Ref: fits in this dia	
500.00	Height of sides	
	Lower	Upper
Deploy Set 1?	1	1
Deploy Set 2?	1	1
Deploy Set 3?	1	1
Deploy Set 4?	1	1
Deploy Depth?	1	1
48°	Lower Deploy angle	
373.62	Lower Deploy Length	
48°	Upper Deploy angle	
373.62	Upper Deploy Length	

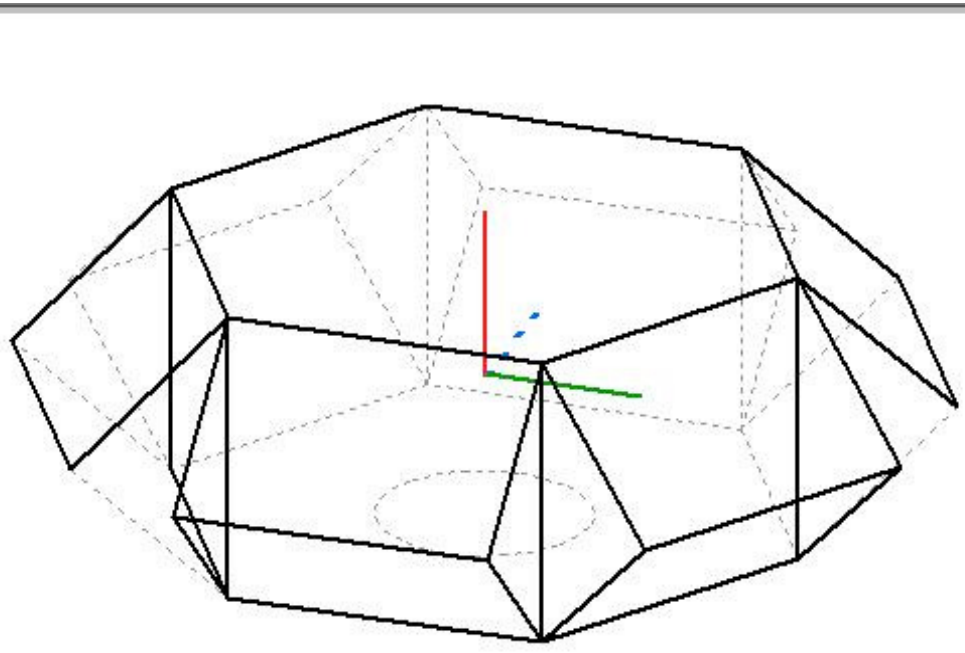
Solar Cell "Packing Ratios"	
0%	Top
0%	Bottom
0%	Sides
90%	Lower Deployables
90%	Upper Deployables

Efficiency of cells	25.0%
(Si 14.8%, GaAs 18.5%, Multi 22%)	
Temperature efficiency	85%
P_o = effc*efft*1367 W/m^2	290.488
Motorized Lightband	15.00
Units	mm
Show "Power Ball"?	0

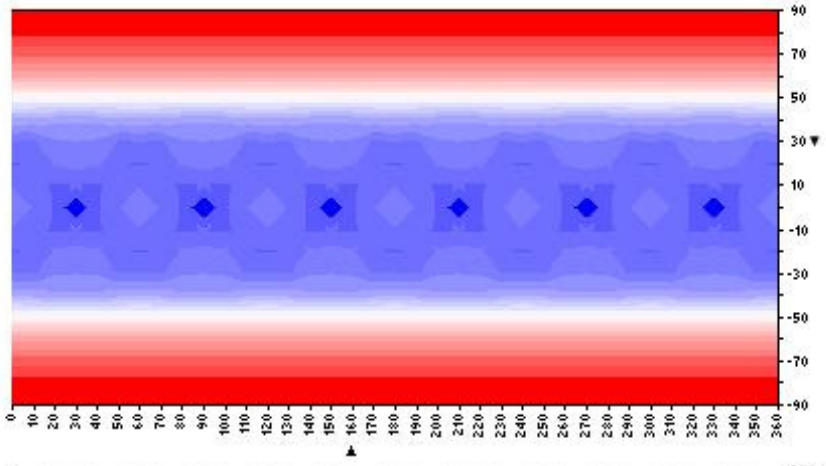
Project Name

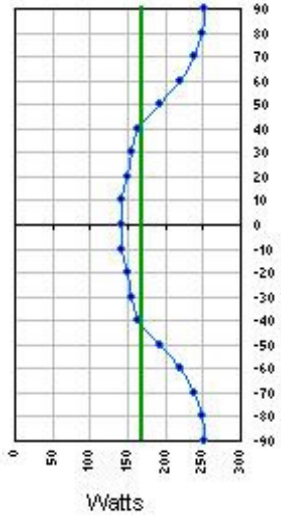
Eagle Large 2007 Feb 28

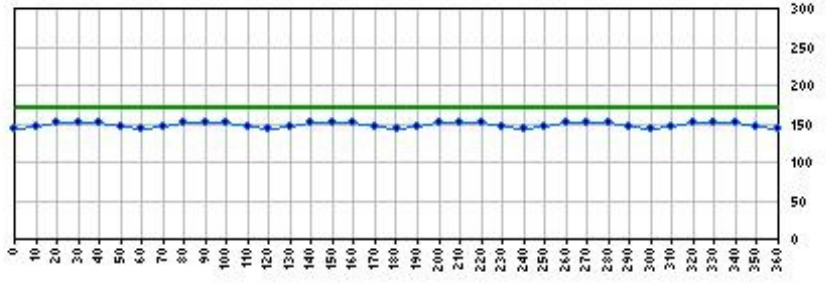
Notes

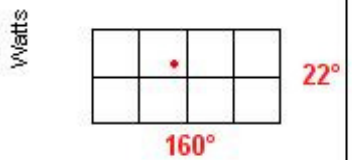


Solar Power vs Orientation



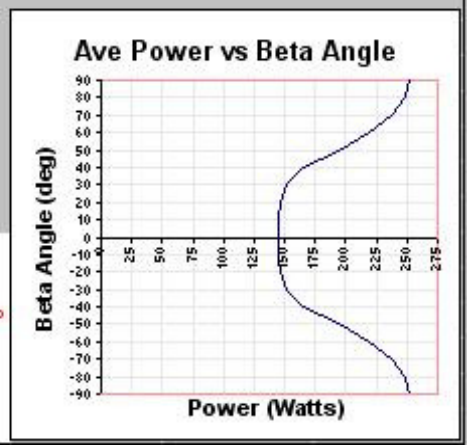






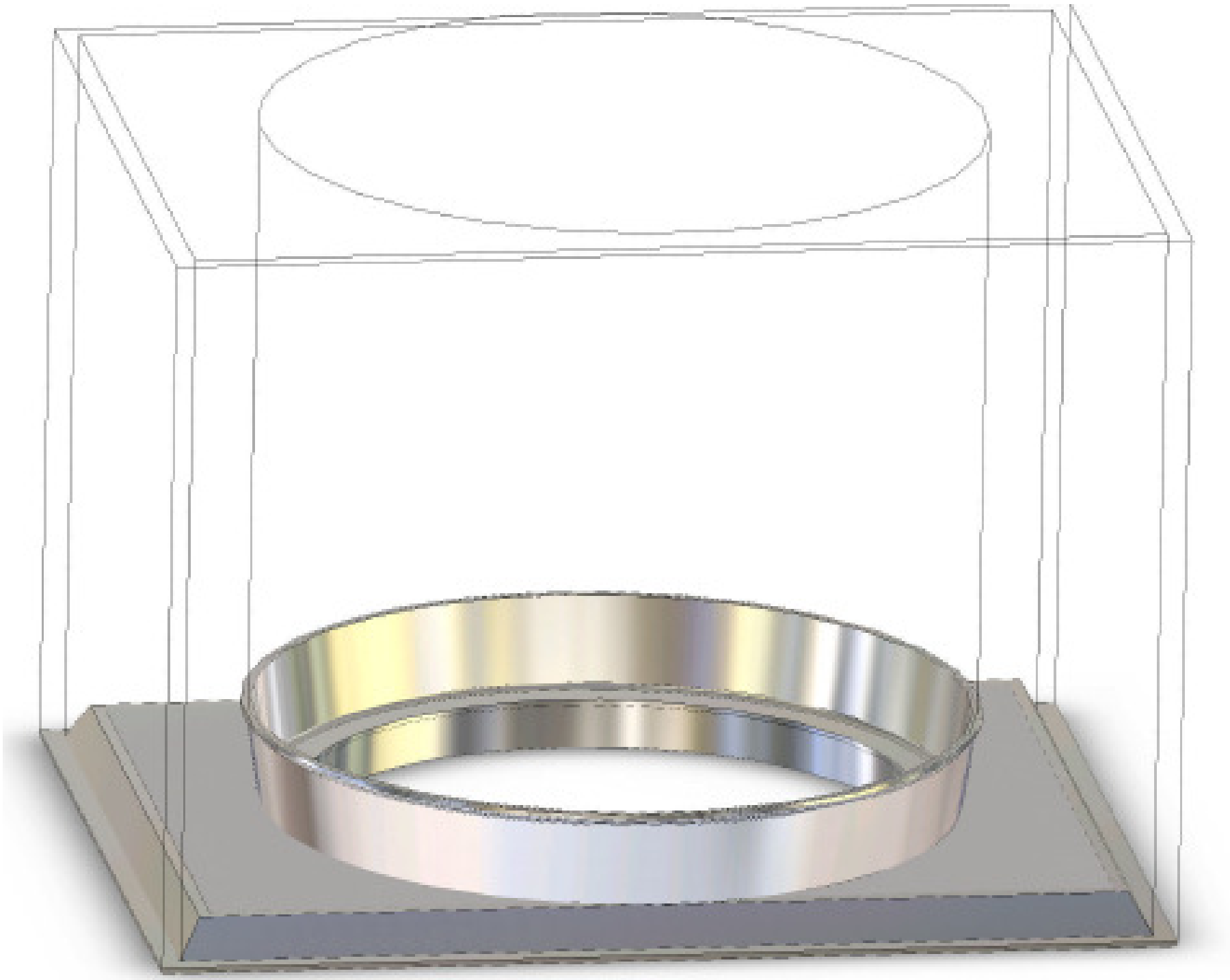
This View	A, mm^2	Power, W
Top	0.00E+00	0.00
Bottom	0.00E+00	0.00
Side 1	0.00E+00	0.00
Side 2	0.00E+00	0.00
Side 3	0.00E+00	0.00
Side 4	0.00E+00	0.00
Side 5	0.00E+00	0.00
Side 6	0.00E+00	0.00
Side 7	0.00E+00	0.00
Side 8	0.00E+00	0.00
Lower 1	5.94E+04	17.26
Lower 2	3.84E+04	11.15
Lower 3	0.00E+00	0.00
Lower 4	0.00E+00	0.00
Lower 5	0.00E+00	0.00
Lower 6	0.00E+00	0.00
Lower 7	0.00E+00	0.00
Lower 8	0.00E+00	0.00
Upper 1	1.68E+05	48.80
Upper 2	1.47E+05	42.70
Upper 3	3.33E+04	9.67
Upper 4	0.00E+00	0.00
Upper 5	0.00E+00	0.00
Upper 6	7.53E+04	21.88
Upper 7	0.00E+00	0.00
Upper 8	0.00E+00	0.00
This View	**5.21E+05**	**151.45**

All Angles	**Max Power**	**252.61**
	Ave Power	**169.95**
	Min Power	**131.32**



Stiffness of Launch Vehicle Adapter

- Dick Jansson KD1K completed cursory examination of this most important structural element
- Attaches spacecraft “box” and fuel tank with 15” diameter separation system
  - Details of launch vehicle separation are assumed, but this is a common standard and quite appropriate for Eagle
- Initial check was encouraging
- Detailed analysis needed later



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Next Steps for Structure

- Complete detailed design
- Support packaging of antenna configuration
- Fabricate solar panel engineering unit
  - This item is critical to mission success and deserves extra testing
- Fabricate spacecraft structure engineering unit
  - Hoping to avoid learning our lessons too late!

2008 is a good year to build something!

Available Online

http://www.amsat.org/amsat-new/eagle/

EaglePedia

The Eagle Satellite Documentation Project

Volunteers always welcome!

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